Appendix G
Research Proposal

Evaluation of the influences of salvage and salvage intensity on wildlife
A research prospectus

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Recent fires throughout the western states have heightened interest in the influences of post-fire management activities on a variety of ecological processes, social goods and services, and forest attributes, including forest health, ecosystem integrity, future management options, and wildlife habitat (McIver and Starr 2000). Salvage of dead trees has been of particular interest because of the potential economic benefits of harvest activities and the influences of salvage on risk of future fire and insect outbreaks. Salvage also has been highly controversial because of known or hypothesized environmental impacts on soil, water, and biodiversity. Despite the coupling of potential social benefits and possible environmental impacts, a large number of questions remain about basic relationships between salvage and ecosystem response.

A key issue related to salvage activities concerns potential influences on wildlife and wildlife habitat. Most research of the effects of post-fire salvage logging has been conducted on avian species although some work has been conducted on other wildlife taxa (e.g., Haim and Izhaki 1994). In general, bird species richness and abundance generally are lower in burned stands that are heavily salvaged relative to unsalvaged stands (Caton 1996, Hitchcox 1996, Saab and Dudley 1998). However, substantial gaps in our knowledge remain concerning the effects of salvage on wildlife, and most of the research has been conducted outside of the Pacific Northwest (reviewed by Kotlier et al. 2002). Most notably, there are few studies that examine influences of different levels of salvage logging on wildlife. Moderate salvage logging that retains sufficient numbers of suitable snags may not have negative effects on some cavity nesting bird species (Saab and Dudley 1998). Existing research suggests that avian species most closely tied to early post-fire habitat may be most sensitive to salvage (Kotlier et al. 2002). As a consequence of lack of geographically relevant information, short- and long-term responses of wildlife populations to changes in forest structure resulting from salvage, the influences of different salvage intensities on wildlife response, and implications for development of late-seral attributes remain speculative.

This prospectus provides an outline of proposed research to investigate the influences of post-fire salvage and salvage intensity on wildlife response in the Timbered Rock Fire in the Butte Falls Resource Area of the Medford District of the BLM.

Objective

To determine the relative influence of 2 salvage intensities on wildlife populations.

Study area

This research will take place on lands managed by the Butte Falls Resource Area, Medford District of the BLM in areas burned during the Timbered Rock fire. The Timbered Rock Fire burned roughly 27,000 of federal and private forest in July, 2002. Approximately 11,775 acres of the fire occurred on lands managed by the BLM. The BLM lands are designated as Late Successional Reserve under the Northwest Forest Plan.

In collaboration with staff of the Medford District of the BLM, potential study sites within the Timbered Rock Fire were identified. Sites meeting the following criteria were considered to be potential sites for study: 1) the site had burned with a high fire intensity, 2) the site was at least 30 (preferably at least 40) acres in size, and was not exceptionally sinuous in shape or did not include elongate extensions, 3) the sites consist of good stocking of conifers $\geq$ 40 inches dbh, 4) the site could accommodate at least three non-overlapping 80 m radius bird survey circles, and 5) it was logistically feasible and reasonable to assign any treatment to any site. Initially, 16 sites were identified by the BLM that were thought to meet the criteria provided. On further investigation, it was found that four of these sites had inadequate numbers of large diameter trees to meet our criteria. These 4 sites were eliminated, resulting in 12 sites available in the area for the study.

Treatments
Three treatments will be implemented in the study:

1) Control. No salvage activity will occur on control sites.

2) Moderate salvage prescription. Salvage activities will occur on 70% of the site. In the salvaged area, six trees per acre, > 20 inches DBH will be retained. Retained snags will be dispersed throughout the salvaged area. The remaining 30% of the site will not be subjected to any salvage activity. If riparian areas are present, the unsalvaged will be oriented to include the riparian habitat. This prescription is designed to emulate likely salvage activities on BLM lands in the region, where sensitive areas, such as riparian areas, are left unsalvaged.

3) Heavy salvage prescription. The entire site will be salvaged. Six trees per acre >20 inches DBH will be retained throughout the site. Retained snags will be dispersed throughout the site.

Treatments were randomly assigned to stands. The resulting allocation of treatments is illustrated in Figure 1.

Aside from salvage activities, all management activities will be identical among treatments. For example, each area should receive the same underplanting density, vegetation control, etc. To the extent that activities undertaken on the sites do not impact the field experiment, all management activities conducted on the sites will be as similar to typical operational practices as possible.

Timing of salvage

Salvage should occur during a relatively narrow window of time to minimize impacts of salvage on data collection and to maintain the integrity of the research design. Salvage treatments should be installed so to meet three criteria: 1) no salvage activity should take place in the experimental plots from May 15 through July 7, to avoid data collection during the breeding bird season; 2) all salvage will be installed during the same time period, on a given year from July 7 through May 15 of the following year (e.g., between July 7, 2003 and May 15, 2004); and 3) no logging will occur on stands adjacent to or nearby to the experimental plots between May 15 and July 7 before 10:00AM.

Field methodologies

Bird populations. During the summer of 2004, we will establish 3 bird-sampling points in each experimental stand. Sampling points will be the chosen so that the distance between points is at least 160 m, and arranged so as to maximize distance between sampling points and stand boundaries. We will conduct bird sampling at each point between May 15 and July 7 during 2004 and 2005. Additional years for study will be determined later in consultation with the BLM, depending on interest and availability of funding. Sampling at least through 2007 may be desirable as changes in habitat structure during the initial years following fire and salvage can be dramatic. We anticipate 2 to 5 years of initial study to evaluate short-term impacts of salvage on birds, followed by additional future work to evaluate moderate- and long-term impacts. Each point will be visited a minimum of four times each year. Bird sampling will be conducted for an 8 minute time period at each point, between one-half hour before and three hours after sunrise. Distances from the observer to each bird will be recorded, and data will be analyzed using standard methodologies. Whenever possible, population density will be estimated rather than using indices of abundance. We will explore use of territory mapping or behavioral observations to evaluate patterns of habitat use within study sites.

Small mammals. Small mammals are of interest because of the key ecological role they play as predators of seeds and insects, dispersers of seeds and mycorrhizal fungal spores, and prey to northern spotted owls and other predators. Although size of the proposed treatments are not suitable to investigate treatment influences on flying squirrel population densities, they are adequate to evaluate use of sites by flying squirrels, and population-level responses of woodrats and other small mammals, including chipmunks, mice, voles, and shrews. We will establish a grid of Tomahawk live traps (for flying squirrels, woodrats, and chipmunks), and Sherman live traps or other traps (for mice, voles, and shrews) at each of the study sites. Trapping will be conducted for a minimum of five days during the spring and fall of 2004 and 2005. Additional years for sampling will be determined later in consultation with the BLM, depending on interest and availability of funding. We anticipate 2 to 5 years of initial study to evaluate short-term impacts of salvage on small mammals, followed by additional future work to evaluate moderate- and long-term impacts. Investigation of response of these species would involve establishing trapping grids on the sites and standard mark-recapture analyses (Thompson et al. 1998). Whenever possible, population density will be estimated rather than using indices of abundance.

Significance and Justification

Salvage and Late Successional Reserves

The Record of Decision (ROD) for the Northwest Forest Plan provides basic guidelines for the conditions under which salvage may occur in Late Successional Reserves. The ROD allows for salvage to prevent negative effects on late-successional habitat and to facilitate habitat recovery. The ROD specifically addresses the potential use of salvage to reduce catastrophic insect, disease, and fire threats. However, the ROD restricts activities that diminish habitat suitability in Late Successional Reserves now or in the future. Unfortunately the information base to fully evaluate the influences of salvage activity on habitat restoration and the short- and long-term impacts of salvage on habitat suitability is not available. This work would provide information on the influences of salvage and salvage intensity on habitat quality and abundance of wildlife species. In addition, if resources are directed to examining influences of salvage on stand structure, research on these sites could provide information on the influences of salvage on habitat recovery and development of late successional characteristics.

Applicability of findings beyond the Timbered Rock Fire

The proposed research will help fill a number of important gaps in our understanding of the influences of salvage on wildlife populations. The experimental, manipulative approach outlined here, combined with random allocation of treatments to sites proposed for this project provides the framework for inference of causality with minimal bias. In contrast, observational research is correlative in nature and cannot be used to infer causality, and research that does not invoke randomization of treatments and controls are subject to potential sampling biases. As a result, very strong inference can be gained from this research and it is likely to impact post-fire management on other public and private lands in southwestern Oregon and throughout the western states.

Deliverables

Products of the proposed project for delivery to the BLM will include annual progress reports during the years when active research is being conducted. In addition, I anticipate that the proposed research will yield at least 2 Master's theses and 3-5 peer-reviewed scientific journal articles (depending on the time frame of the study and the number of wildlife taxa examined).

Project Schedule

Below is a potential schedule for research, based on four years of initial post-treatment data collection. Actual duration of the initial data collection is subject to funding availability. Timing and duration of second and third data collection sessions is subject to modification depending on availability of funding, interest of the BLM, patterns of stand development, and findings of the initial data collection sessions.

Years 1-4
: Initial post-treatment data collection on wildlife populations and habitat characteristics.

Year 5
: Analysis and publication of initial post-treatment data.

Years 10-11
: Additional post-treatment data collection on wildlife populations and habitat characteristics.

Year 12
: Data analysis and publication of results.

Years 18-19
: Additional post-treatment data collection on wildlife populations and habitat characteristics.

Year 20
: Data analysis and publication of results.

Budget

Separate budget estimates are provided here for two studies: a bird response study and a small mammal (spotted owl prey species) response study. Both studies include habitat assessments as well as direct evaluation of wildlife communities.

Costs are provided for the first 6 years of the project (years –1 through 5); actual costs for years 3-5 will depend on decisions made concerning the amount of field sampling to be done. Similar expenses for later entries could be anticipated, modified based on inflation. Higher costs during year –1 largely reflect costs of supplies for study establishment (mostly traps for the mammal study). If pre-treatment sampling is not possible, these costs would be transferred to year 1. Expenses may be reduced if the BLM is able to provide housing for the field crew and vehicles for field work. Estimates are made based on 15% indirect costs rate for transferring money from the BLM to OSU through the CESU.

Bird study budget

Year	Direct Costs	Indirect Costs	Total
Year 1	57,750	8,862	66,413
Year 2	57,750	8,862	66,413
Year 3	57,750	8,862	66,413
Year 4	57,750	8,862	66,413
Year 5	50,250	7,537	57,788

Mammal study budget

Year	Direct Costs	Indirect Costs	Total
Year 1	98,250	14,737	112,988
Year 2	77,250	11,587	88,838
Year 3	77,250	11,587	88,838
Year 4	77,250	11,587	88,838
Year 5	53,250	7,987	61,238

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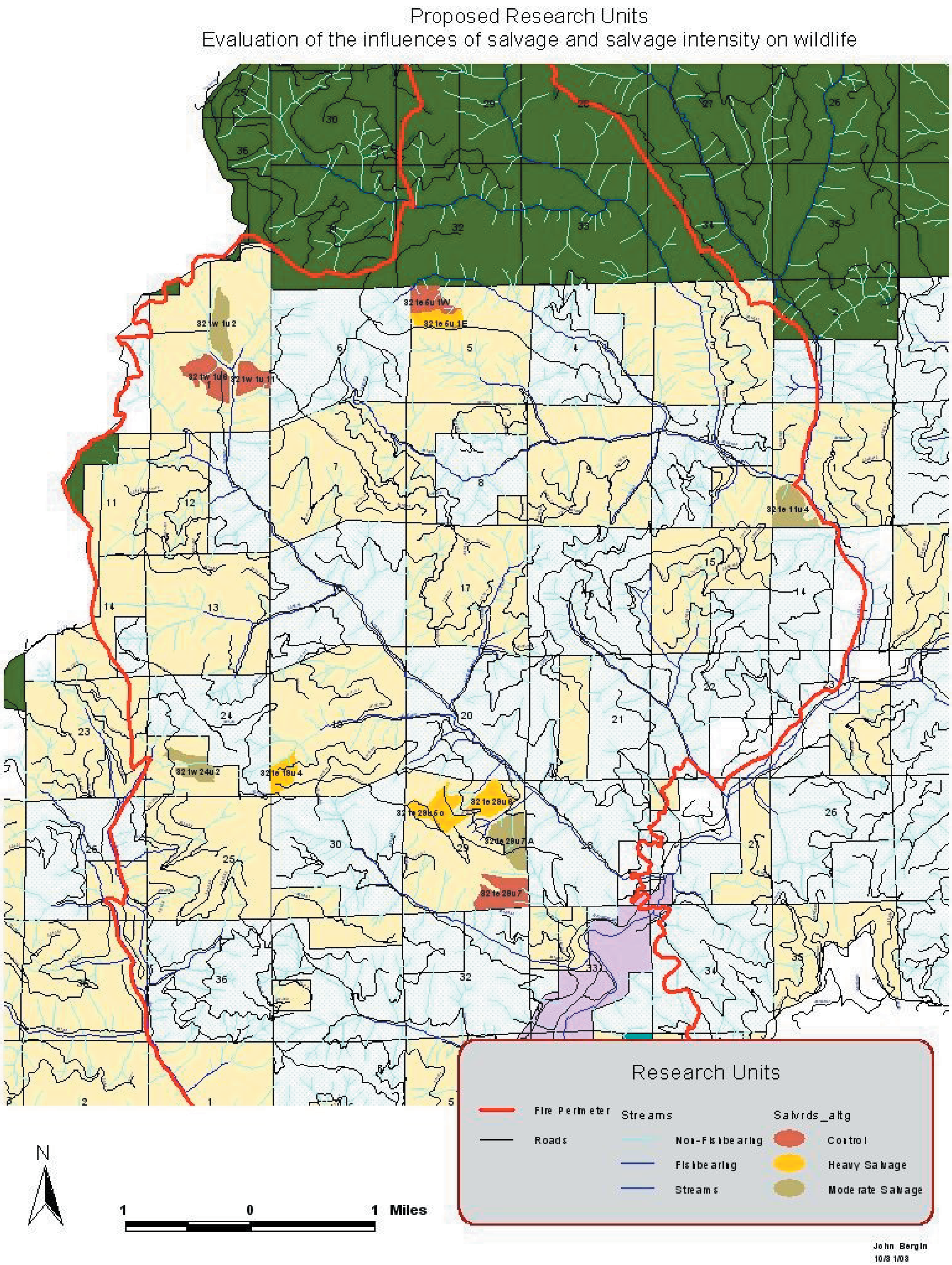

Figure 1. Location of research units.

Vegetation Dynamics and Fire Hazard in Experimental Mixed-species Restoration Plantings in Southwestern Oregon:

The Timbered Rock Fire
Butte Falls Resource Area, Medford BLM

A Research Proposal to the USDI Bureau of Land Management

by

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Issue

Recent large-scale fire events have degraded functional characteristics of upland forests over extensive areas and placed at risk ecosystem stability, productivity, habitat, and water quality. Reforestation efforts are being considered to enhance development of forest communities that serve a broad spectrum of ecological functions and vary in temporal development with respect to fuels structure and fire risk. Mixed-species plantings have been increasingly employed since the mid-1980's as an adaptive management option and yet remain poorly documented in terms of stand development and, in particular, interactions among species of planted trees, as well as interactions among planted trees, natural tree regeneration, and associated shrub, herbaceous, and non-vascular vegetation. Further, there is a paucity of information regarding temporal and spatial dynamics of fuels structure and abundance in mixed-species plantations. Addressing these information gaps will provide managers with an improved understanding of the potential role of mixed-species plantings for meeting goals of ecosystem restoration and enhanced function, and for improving fuels hazard analyses and fuels management strategies.

Background:

Fire is a natural process driving structure and function of many Pacific Northwest forest ecosystems including those in southwestern Oregon (Agee 1993). Over the past several decades, disruption of natural fire cycles characterized by high frequency low intensity burns has resulted in forest structures characterized by high fuel loads and vertical and horizontal canopy distribution favorable for large-scale high intensity stand replacement fires.

Post-fire management objectives tend to focus on site stabilization, capture of potential merchantable wood, reforestation and minimization of risk for recurrent high-intensity fires. On federal lands in the Pacific Northwest these objectives are differentially considered in the contexts of various land allocations such as matrix, late-successional reserves, adaptive management areas, and riparian reserves. The suite of tools available for post-fire management is defined in part by Standards and Guidelines put forth in the Record of Decision guiding US Forest Service and US Bureau of Land Management planning (Anon. 1994).

Two post-fire management activities employed are salvage logging and reforestation. Each of these activities generates its own set of issues and controversy regarding the appropriateness of application. Proponents justify the implementation of salvage logging as a means to recover economic value and to decrease fuel loading by removing fire damaged logs and snags before the onset of decay. Reforestation is often undertaken with the objective of enhancing development of tree cover. Conflicts arise between different perspectives on the degree of environmental, economic and social risks and benefits associated with the implementation or lack of implementation of these practices (McIver and Starr 2000, eg. Beschta et al. 1995). Until the consequences of post-fire management practices are known with respect to a wide array of values these conflicts can not be fully addressed.

The ways in which salvage logging and reforestation are applied can possibly have substantial impact on stabilization of burned sites and the subsequent nature and rate of vegetation development. Given Standards and Guidelines defined in the ROD (1994), salvage logging may be an infrequent activity in many land allocations, while reforestation may have a broader range of implementation. The remainder of this discussion will focus primarily on reforestation and will address snag removal (salvage logging) as it directly relates to reforestation and vegetation dynamics. Artificial reforestation techniques have been developed largely in the context of economic forest management where rapid development of tree cover is a major goal (Hobbs 1992). As a result, our discussion of reforestation will draw largely upon knowledge gained from post-harvest reforestation efforts. We will address basic reforestation concepts with respect to natural regeneration as a baseline and with respect to fire as a disturbance.

Fire of intensity sufficient to cause extensive tree and shrub mortality reinitiates succession processes. The subsequent course of natural forest regeneration is determined by abundance and proximity of seed sources, seedbed characteristics, and the pre-burn presence and post-burn survival of sprouting species.

Natural regeneration of conifers is dependent upon seed and seedbed conditions suitable for germination and establishment of seedlings. Production of large seed crops varies by species with intervals ranging from 2-11 years for Douglas-fir, 3-9 years for white fir, and 2-8 years for ponderosa pine (USDA 1965). Fires may act as thinning agents in which large healthy canopy trees are released to produce greater seed crops within a few years following the burn. Conversely, trees experiencing severe fire damage may not respond to release in the near term. There is little information available on the effects of fire on seed production (Minore and Laake 1992).

Seed dispersal is predominantly driven by topography and wind. Dispersal abundance decreases exponentially with distance from the source tree (Hobbs et al. 1992). Dispersal distance tends to be greater from tall trees and for species with light seeds (eg. Douglas-fir) versus those with heavy seeds (eg. Sugar pine). These factors tend to result in high degrees of spatial and temporal variation in seed availability. In areas where all seed-bearing trees are killed or removed in salvage harvests, seed supply may be insufficient for conifer regeneration in the near term.

Typically, even low intensity fires alter the seedbed conditions by removing the duff and litter layers. Thus, after they have been leached by rain, seeds on moderately burned seedbeds showed higher germination success of Douglas-fir and white fir (Minore and Laake 1992). Conversely, on severely burned sites physical changes in soil conditions, such as reduced infiltration and percolation, increased pH, and reduced mycorrhizal associations, can greatly diminish seedbed quality. Darkening of the soil surface by charcoal residue can result in higher surface temperature that may stimulate seed germination in the spring but cause heat injury to the stems of young seedlings later in the growing season (Minore and Laake 1992). This is especially critical in the climate of southwest Oregon after overstory vegetation and shading slash have been removed by fires.

In contrast to conifers, several hardwood tree and shrub species can regenerate either by seed or vegetatively from stump or root sprouts (Tappeiner et al. 1992). Seeds of many woody shrubs species (eg. manzanita or ceanothus) accumulate and remain viable in the soil. Fire can stimulate germination of these seeds leading to a flush of new shrubs that can readily occupy site resources (Biswell 1989, Tappeiner et al. 1992). Further, fires of moderate intensity may consume the above-ground shrub canopy without causing mortality to the below-ground root system. Sprouts from the surviving stump and root system can often proliferate resulting in the rapid establishment of a vigorous shrub canopy (Biswell 1989). Abundant shrub development can severely inhibit conifer establishment and growth.

Because of the uncertainty associated with natural regeneration of conifers following fire, artificial reforestation, usually tree planting, is often undertaken in southwestern Oregon to establish conifers. Wildfires function as natural site preparation by killing competing vegetation and removing barriers to seedling development such as slash. However, as previously indicated, the wildfires may also serve to stimulate woody shrub seed banks and sprouting which on direr sites may be strongly competitive and a hindrance to planted seedling survival and growth (Helgerson et al. 1992).

Once seedlings are planted, weeding treatments may be required to ensure survival or growth, depending on management objectives and the current and anticipated development of competing vegetation. As germinants of competing species are not as vigorous as established plants, release treatments may be more effective after fires as compared to harvested or undisturbed sites. Alternatively, sprouting vegetation may reoccupy sites rapidly and even a short delay (e.g., to grow seedlings in a nursery or wait for a good seed crop) may lead to substantial limitations with crop tree survival and growth (Helgerson et al. 1992).

Residual live trees and fire-killed snags are often salvaged after a burn. The impacts of salvage harvest on reforestation efforts have not been explicitly addressed. The body of research effectively documenting impacts of salvage logging on site and vegetation development is very limited (McIver and Starr 2000). Specific impacts of salvage logging vary with a variety of factors, including pre-fire vegetation composition (especially presence of sprouting species), fire intensity, slope, soil texture, and post-fire and harvest weather conditions. Depending on the harvesting system used, salvage logging may influence regeneration through removing downed woody debris, by disturbing the soil surface to expose mineral soil or by disrupting impermeable hydrophobic layers in the soil. Salvage logging has also been shown to have at least some short-term influence on vegetation development as characterized by herb, shrub, and sapling abundance, by species diversity, and by vegetation biomass (McIver and Starr 2000). Compared to unlogged burned controls, areas that were post-fire salvage logged and subsequently broadcast burned had a higher coverage of hardwoods and these hardwoods inhibited the establishment and growth of Douglas-fir (Stuart et al. 1993). Additional disturbances of the logging process may also encourage establishment of native ruderal species and exotic invaders (Abrahamson 1984). In addition to site disturbance effects, salvage logging may also remove snags and woody shrub skeletons that provide shade and a mosaic of microsites in which harsh microclimatic conditions (temperature and evaporative demand) are moderated. Although there has been little explicit documentation of benefits of shade provided by snags, at least one study has demonstrated that shade from dead shrub canopies was beneficial to the survival and growth of planted white fir on dry sites in California (Conard and Radosevich, 1982).

Long-term forest structure and species composition depend upon events that occur within the first few years after the fire. Helms and Tappeiner (1995) provide a qualitative model that fits the situation in southwest Oregon and illustrates this point. If no conifer seeds are available and shrub germinant or hardwood sprouts are dominant early on, the shrub/hardwood community may persist for many years. Eventually shade tolerant species may invade to form a pure stand after overtopping the shrubs and hardwoods. Alternatively, if seed is present or trees are planted, a more rapid development of a mixed conifer (shade intolerant and shade tolerant species) may take place. Delay of planting or seeding of intolerant species or failure to control competing shrubs after planting may result in development of a shrub/hardwood community or mixed true fir shrub/hardwood community. There are many possible variations of these themes that may occur at various scales and depending on seed dispersal, shrub and hardwood densities, etc.

As short-term changes in growing conditions are reflected in the long-term development of tree and shrub cover, they also impact future fire potential and behavior. The primary issues of concern are the potential for resetting of the successional process, thus delaying development of late-successional habitat, and potential changes to long-term site productivity induced by high severity fires. Post-fire management activities are aimed at reducing the amount of large wood on the site through salvage logging and accelerating the development of forest structures that are more resistant to fires through reforestation activities. Areas dominated by a dense shrub cover (e.g., ceanothus species) and young, dense plantations or natural stands are likely to be highly flammable. On the other hand, if trees establish and grow quickly, natural stand development will lead to lower density of (flammable) understory vegetation. Potential for crown fires is reduced once crown lift occurs and when tree crowns are spaced further apart (Graham et al. 1999). Subsequently, pre-commercial thinning and understory fuel treatments, such as shrub busting or prescribed burning, are commonly used to reduce the potential for future crown fires in these stands (Graham et al. 1999). Thus, rapid development of stands may reduce the time period when stands are highly susceptible to stand replacing fires by speeding up development towards forest structures with lower flammability (Graham et al. 1999).

Objectives:

The general objectives of this study are to evaluate mixed-species reforestation plantings to identify and characterize temporal patterns of vegetation structural development and species diversity; to assess temporal dynamics of fuels loading and fire risk; and to determine impacts of snag retention on survival and growth of planted and naturally regenerated trees.

Implicit in the generalized objectives stated above are short- and long-term research issues. For initial phases of stand development covered in this proposal, six specific research objectives include to determine effects of:

1) snag retention on the survival and establishment of planted seedlings by species,
2) planted seedling versus natural regeneration on tree survival and growth,
3) monoculture versus mixed-species plantings on planted seedling survival and growth,
4) planting density on survival and growth of planted seedlings by species, and site occupancy by planted and naturally regenerating trees, shrubs, and herbs,
5) weed control on planted seedling establishment and growth of trees, shrubs, and herbs, and
6) physiographic site conditions on planted seedling survival and growth of trees, shrubs, and herbs.

Research Approach:

A replicated field experiment will be conducted to evaluate reforestation by mixed-species plantings as influenced by planting density, woody vegetation removal, dead structure (fire-killed snag trees and shrubs), and physiographic site (harsh or moderate sites). Treatments for establishment of planted trees will be designed to reflect planting schemes that are being undertaken at broader, operational scales. Experimental plantings will be evaluated with respect to vegetation structure, plant diversity, fuels, fire risk, and tree mortality, stress, growth, and productivity. The degree of site and treatment control in the experimental plantings will permit a more explicit evaluation of treatment and site factors than obtainable from monitoring or retrospective analysis of operational mixed-species plantations being established by the BLM in the Elk Creek Watershed.

Treatments and Experiments:

Experimental factors will consist of species mix, planting density, woody vegetation removal (weeding), snag retention (salvage), and physiographic site. These factors will be tested as a modular experimental design. A basic set of six planting treatments varying in composition, density, and competing vegetation will be employed. Depending on specific research objectives listed above, differing numbers of the six basic treatment plots will be established on harsh or moderate sites, or sites with or without snags.

The basic composition, density and weed treatments are:

Unplanted, not weeded (no woody vegetation removal)
Douglas-fir monoculture, weeded (woody vegetation removal through age 5)
Mixed species, 435 tpa (high density, 10' x10' spacing), not weeded
Mixed species, 435 tpa, weeded
Mixed species, 190 tpa (low density, 15' x 15' spacing), not weeded
Mixed species, 190 tpa, weeded

The basic treatment plot size is 1.5 ac (256' x 256') with the interior 1 ac (209' x 209') serving as the measurement plot.

In addition to the basic treatments listed above, physiographic site condition and snag retention will be included as experimental factors. Physiographic site conditions will be included through planting a subset of the six basic treatments on harsh and moderate sites as defined predominantly by aspect (southerly versus northerly), but also considering soil characteristics and slope position. Snag effects will be tested by planting a subset of the six basic treatments on sites with and without snags.

Three modular experiments are described below. Each module is designed to achieve statistical power for testing hypotheses specific to individual objectives. Each module will be analyzed separately, but all modules will have a subset of treatments in common to allow for limited interpretation of responses across modules.

Experiment A: Determine interactive effects of species composition, planting density, and weed control on seedling survival and early growth and site occupancy by planted seedlings and natural vegetation.

Objectives addressed: 2-5

Design: Five replications of the six basic treatments will be established on harsh sites with snags.

Rationale – This represents a base level test of the effects of species composition, planting density and weeding on plantation establishment and associated developmental responses of natural vegetation. Early responses, prior to tree canopy closure, represent individual tree and species responses to environmental heterogeneity. It is our assumption that salvage will not be the norm in fire restoration so this experiment will be conducted on sites with fire-killed snags. Conducting this experiment on harsh sites will result in an early expression of individual plant and species responses to the density and weed treatments.

Experiment A will be planted in 2004.

Experiment B: Determine effects of snags on survival and growth of planted seedlings.

Objectives addressed: 1

Design: Six replications of mixed species, high density, weeded treatments planted on harsh sites with and without snags.

Rationale: Snags will introduce microsite heterogeneity (light and possibly temperature and soil moisture modification). It is hypothesized that this microsite heterogeneity will result in different levels of mortality and early growth among planted tree species. Shrub skeletons and natural regeneration will be removed to provide an explicit test of the contribution by snags. Further, testing on harsh sites will result in an early expression of individual tree and species responses to snag moderation of microsite severity.

Experiment B will be planted in 2005.

Experiment C: Determine effects of physiographic site conditions on survival and growth of planted seedlings, and development of naturally regenerating herbs, shrubs and trees.

Objectives addressed: 1, 6

Design: Six replications of mixed species, high density, weeded and unweeded treatments; planted on harsh and moderate sites with snags.

Rationale: Resource availability and microclimate are influenced by physiographic site conditions and by competing vegetation. This experiment will permit differentiation of these two factors as they relate to seedling and species establishment. Snags will introduce additional microsite heterogeneity that will be exploited to differing degrees by different species of planted trees and naturally regenerating vegetation. Experiment C will be planted in 2004.

Experimental Layout:

Implementation of the three modular experiments will require 56 1.5-ac plots. Where common treatments exist among modules, individual plots will contribute to multiple experimental analyses. Allocation of plots to individual experiments and in terms of specific treatment conditions required are summarized in tables 1 and 2, respectively.

Experimental units will be identified in 2003 and randomly assigned treatments. Plot layout will occur in 2004. Plots used in Experiments A and C are not dependent upon salvage and will be planted in 2004. Plots used in Experiment B are dependent upon the completion of salvage and will be planted in 2005.

Table 1. Allocation of treatments by experiment. Note that acreage and plots totals across experiments will exceed the totals in Table 2 because some of the plots that receive treatments in common will be shared in multiple experiments.

Composition	Density (tpa)	Weeding	Site (aspect)	Salvage	# Plots	Acres (min.)
Experiment A (2004 Planting)						
No planting	0	Not weeded	Southerly	No salvage	5	7.5
Douglas-fir	435	Weeded	Southerly	No salvage	5	7.5
Mixed-sp.	435	Weeded	Southerly	No salvage	5	7.5
Mixed-sp.	435	Not weeded	Southerly	No salvage	5	7.5
Mixed-sp.	190	Weeded	Southerly	No salvage	5	7.5
Mixed-sp.	190	Not weeded	Southerly	No salvage	5	7.5
Experiment B (2005 Planting)						
Mixed-sp.	435	Weeded	Southerly	Salvage	6	9.0
Mixed-sp.	435	Weeded	Southerly	No salvage	6	9.0
Experiment C (2004 Planting)						
Mixed-sp.	435	Not weeded	Southerly	No salvage	6	9.0
Mixed-sp.	435	Weeded	Southerly	No salvage	6	9.0
Mixed-sp.	435	Not weeded	Northerly	No salvage	6	9.0
Mixed-sp.	435	Weeded	Northerly	No salvage	6	9.0

Table 2. Acreage requirement by treatment condition for experiments A-C, combined.

Composition	Density (tpa)	Weeding	Site (aspect)	Salvage	Planting Year	# Plots	Acres (min.)
No planting	0	Not weeded	Southerly	No salvage	2004	5	7.5
Douglas-fir	435	Weeded	Southerly	No salvage	2004	5	7.5
Mixed-sp.	435	Weeded	Southerly	No salvage	2004	6	9.0
Mixed-sp.	435	Not weeded	Southerly	No salvage	2004	6	9.0
Mixed-sp.	190	Weeded	Southerly	No salvage	2004	5	7.5
Mixed-sp.	190	Not weeded	Southerly	No salvage	2004	5	7.5
Mixed-sp.	435	Weeded	Northerly	No salvage	2004	6	9.0
Mixed-sp.	435	Not weeded	Northerly	No salvage	2004	6	9.0
Mixed-sp.	435	Weeded	Southerly	No salvage	2005	6	9.0
Mixed-sp.	435	Weeded	Southerly	Salvage	2005	6	9.0
Total						56	84

Additional Treatment Details

Species mixes will consist of planted seedlings of the conifers Douglas-fir, white fir, sugar pine, ponderosa pine and incense cedar; and hardwoods sprouts, mainly Pacific madrone and chinquapin oak. Douglas-fir will predominate in all settings, comprising up to 40% of the planted seedlings. At elevations in excess of 3500’ white fir will be planted (10% of seedlings) and the proportion of Douglas-fir will be decreased to 30%. Sugar pine will constitute 20% of the seedlings at all sites. Ponderosa pine and/or incense cedar will contribute an additional 20% of the seedlings. A hardwood component will be included in the mixed-species plots by retaining a proportion of existing sprouts, principally Pacific madrone, and chinquapin oak. If originating as a clump, hardwood sprouts to be retained will be thinned to a single stem.

Removal of woody vegetation (weeding) on specified treatment plots will be achieved by manual cutting methods. The intent of vegetation removal is to facilitate the establishment of planted seedlings; not to provide for long-term maximum tree growth. Cutting will be done in summer after full leaf-out when root carbohydrate reserves are at a minimum. Vegetation removal treatments will be repeated in years 1, 2 and 4, and if needed in year 6, following salvage. After six years, planted seedlings should be established. Subsequent development of woody sprout and seedling development will be untreated.

Harsh and moderate physiographic sites will be identified based predominantly on aspect (northerly versus southerly), but also with consideration of soils (deep versus skeletal) and slope position (mid versus upper).

Response Variables

Response variables to be measured are listed below and classified as either basic or optional. Variables listed as basic are considered essential to meeting the basic objectives for characterizing stand development in terms of vegetation composition and structure; and in terms of fuels structure and fire hazard. Variables listed as optional represent additional opportunities to address basic questions of ecosystem structure, function, and process that would be considered by the principal investigators if they obtain external funding to do so, or cooperators are identified who are willing to undertake these issues.

Basic

- Plant species richness – species list
- Planted tree survival - by species
- Planted tree growth – height, diameter
- Natural tree regeneration density – by species
- Natural tree regeneration growth – height, diameter
- Woody shrub density – by species
- Woody shrub cover – by species
- Woody shrub height and diameter – by species
- Herbaceous species cover – by species
- Snag height and density – by species and diameter class
- Coarse woody debris abundance – by species and diameter class
- Fuels profiles – biomass by combustion class

Optional

- Non-vascular plant species richness
- Non-vascular plant species abundance
- Planted tree leaf area – by species
- Planted tree biomass – by species
- Woody shrub leaf area – by species
- Woody shrub biomass – by species
- Canopy leaf area
- Canopy biomass
- Soil moisture status
- Soil and air temperature profiles
- Planted tree water relations
- Woody shrub water relations
- Planted tree rooting density
- Woody shrub rooting density
- Soil nutrient status
- Foliage nutrient status

Deliverables

Products of the proposed project for delivery to the BLM will include annual progress reports, including preliminary analysis of all vegetation, CWD, and fuels data as generated in years 1-3, and 5; a detailed report of findings in year 4 (covering years 1-3); and a detailed report of findings in year 6 (covering years 1-5).

In addition to the reports to be delivered to the BLM, it is anticipated that the proposed research will yield 1 or 2 Master's theses, a PhD dissertation, and 4-6 peer-reviewed journal articles in the first 6 years following establishment.

Findings will be presented to BLM personnel and at regional and national meetings as opportunities arise.

Partners, Roles and Responsibilities

USFS PNW – Paul D. Anderson, Principal Investigator

- Primary contact, facilitator and coordinator among primary BLM, OSU, and PNW partners
- Establishment of study including treatment and sampling plot layouts
- Primary collection of first year vegetation data
- Collaborator on vegetation data collection, analysis, interpretation, and reporting in years 2 through 6
- Database management and data quality assurance
- Co-advisor of student researchers
- Facilitation and coordination of potential research collaborators and partners
- Advocacy and solicitation for supplemental funding

OSU – Klaus Puettmann, John Tappeiner, Co-principal Investigators

- Primary collection of vegetation data years 2 through 6
- Collaborators on vegetation data collection, analysis, interpretation, and reporting in years 2 through 6
- Recruitment and principal advising of two graduate student researchers
- Advocacy and solicitation for supplemental funding

US BLM – Butte Falls Resource Area

- Advice on study scope, design and implementation
- Provision of study sites
- Purchase of planting stock
- Planting of experimental plots
- Vegetation control for weeding treatments
- Cutting of snags and removal of woody skeletons
- Facilitation of the long-term integrity of study plots
- Potential collaborator on supplemental data collection or research issues
- Potential collaborator on data interpretation and application of results
- Advocacy for supplemental funding

Project Schedule

This proposal explicitly covers activities through 2009. The timing of specific activities is summarized in Table 3. Progress reports will be written annually. Comprehensive analyses and reporting will be done following the third and fifth years after planting. Research activity beyond the fifth-year following planting is anticipated with intermediate- and long-term objectives to be addressed in future proposals and study plans.

Table 3. Schedule of research activities. Letters A, B and C refer to the corresponding experiments. Shaded cells refer to planned activities beyond the scope of this proposal. Beyond year 10, it is anticipated that data collection will occur at five-to-ten-year intervals throughout stand development.

Activity	'03	'04	'05	'06	'07	'08	'09	'10	'11	'13	'14
Establishment/Maintenance											
Experimental unit selection	A B C										
Plot establishment		A C	B								
Planting		A C	B								
Weeding		A C	A C B	B	A C	B	A C	B			
Data Collection											
Plant species richness		A C	A C B	A C B	B	A C	B	A C	B	A C	B
Planted seedling survival		A C	A C B	A C B	B	A C	B	A C	B	A C	B
Planted seedling ht. & diam.		A C	A C B	A C B	B	A C	B	A C	B	A C	B
Natural seedling density		A C	A C B	A C B	B	A C	B	A C	B	A C	B
Natural seedling ht. & diam.		A C	A C B	A C B	B	A C	B	A C	B	A C	B
Shrub density		A C	A C B	A C B	B	A C	B	A C	B	A C	B
Shrub cover		A C	A C B	A C B	B	A C	B	A C	B	A C	B
Shrub volume		A C	A C B	A C B	B	A C	B	A C	B	A C	B
Herbaceous cover		A C	A C B	A C B	B	A C	B	A C	B	A C	B
Snag density		A C	B	A C B	B	A C	B	A C	B	A C	B
Coarse woody debris		A C	B	A C B	B	A C	B	A C	B	A C	B
Fuels		A C	B	A C B	B	A C	B	A C	B	A C	B
Analysis, Reporting			A C	B	A C	B	A C B				

A – effects of species composition, density, and weed control on vegetation dynamics
B – effect of snag retention on vegetation dynamics
C – effects of edaphic site and weed control on vegetation dynamics
Weeding will be done in mid-summer
Herbaceous data will be collected in summer
Tree, shrub, snag, coarse woody debris and fuels data will be collected in the autumn

Estimated Costs

The total proposal budget request to the BLM for the 6-years of project funding is $415,600. These funds are distributed to OSU and PNW in the amounts of $280.4 K to Oregon State University and $135.2 K to PNW. In addition it is anticipated that the BLM will provide vegetation seedling stock, planting, and vegetation and snag removal funds through their operational management activity budgets estimated to total $40 K.
PNW and OSU in-kind contributions (Prinicipal Investigator salaries and PNW Corvallis laboratory indirect costs) total $96.3 K by PNW and $184.3 K by OSU (64.6 K as reduced overhead rate contribution, 119.7 K as in-kind salary). Respectively, this represents a cost-share of 42% by PNW and 66% by OSU, relative to the proposed funding to be received by the two research institutions.

The proposed budget, summarized annually and for the entire 6-year project is presented in Table 4. Detailed individual budgets for PNW and OSU are also available.

Table 4. Annual and total project cost estimates summarized by research institution assuming measurement of the basic response variables.

	Funding Year						
	FY04	FY05	FY06	FY07	FY08	FY09	Overall
Direct Costs							
Salaries and Benefits							
Oregon State University	$5,760	$23,619	$42,869	$25,038	$25,790	$20,811	$143,888
USFS PNW	$18,598	$6,712	$7,047	$4,431	$7,770	$4,886	$49,443
Research Assistant Tuition/Fees							
Oregon State University	$0	$9,273	$19,789	$10,314	$10,755	$11,495	$61,627
Travel							
Oregon State University	$3,000	$4,000	$7,000	$5,200	$4,000	$2,950	$26,150
USFS PNW	$17,070	$7,686	$7,686	$7,686	$7,686	$7,686	$55,500
Other Direct Costs							
Oregon State University	$0	$2,200	$2,800	$2,200	$1,900	$3,100	$12,200
USFS PNW	$1,500	$1,450	$750	$1,500	$1,450	$1,500	$8,150
Total Direct							
Oregon State University	$8,760	$39,092	$72,458	$42,752	$42,445	$38,357	$243,864
USFS PNW	$37,168	$15,848	$15,483	$13,617	$16,906	$14,072	$113,093
Indirect/Overhead							
Oregon State University	$1,314	$5,864	$10,869	$6,413	$6,367	$5,754	$36,580
USFS PNW	$7,248	$3,090	$3,019	$2,655	$3,297	$2,744	$22,053
TOTAL Request							
Oregon State University	$10,075	$44,956	$83,327	$49,165	$48,812	$44,110	$280,444
USFS PNW	$44,416	$18,938	$18,502	$16,273	$20,202	$16,816	$135,146
Annual Totals	**$54,490**	**$63,894**	**$101,829**	**$65,438**	**$69,014**	**$60,926**	
Project Total							**$415,591**
In-kind Contributions							
Direct Costs							
PI Salary - OSU KP (0.07* FTE)	$4,204	$11,083	$11,686	$12,319	$12,984	$13,682	$65,959
PI Salary – OSU JT (0.10 FTE)	$4,500	$9,270	$9,548	$9,835	$10,130	$10,433	$53,716
PI Salary - PNW PA (0.12 FTE)	$9,840	$10,332	$10,849	$11,391	$11,961	$12,559	$66,931
Indirect Costs							
OSU Overhead Reduction	$2,321	$10,359	$19,201	$11,329	$11,248	$10,165	$64,624
PNW CFSL Charge	$10,660	$4,160	$4,160	$3,120	$4,160	$3,120	$29,380
Annual Totals	**$31,525**	**$45,204**	**$55,444**	**$47,994**	**$50,482**	**$49,959**	
Project Total							**$280,608**

*** For budget year 2003 FTE is 0.04.**

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Scientist Biographies

Robert E. Gresswell received degrees from the University of New Mexico (BS), Utah State University (MS), and Oregon State University (PhD). Since 1997, Bob has been working as an aquatic ecologist for the USGS Forest and Rangeland Ecosystem Science Center and the CFER Program. He is also a courtesy assistant professor with the Department of Fisheries and Wildlife at Oregon State University. His interests concerning the influence of land-use activities on forested ecosystems have led to research on the relationships among landscape-scale environmental features, instream habitat characteristics, and coastal cutthroat trout abundance and distribution in watersheds in western Oregon.

John P. Hayes is program coordinator and a wildlife ecologist for the CFER program. He also serves as an associate professor in the Department of Forest Science at Oregon State University where he teaches coursework in forestry-wildlife interactions. John received his BS in Wildlife Science at Oregon State University, his MS in Biology at Southern Oregon State College, and his PhD in Ecology and Evolutionary Biology at Cornell University. His research interests include the influence of forest management on wildlife populations, the influence of spatial scale on habitat selection, and the ecology and management of bats.

Steven Perakis joined the CFER research team as a research ecologist with the USGS Forest and Rangeland Ecosystem Science Center. Steve's research centers on understanding biogeochemical cycles in terrestrial ecosystems, and he has particular interest in discerning how processes and activities within forests shape nutrient losses, whole-system nutrient balances, and linkages between terrestrial and aquatic ecosystems. Steve has degrees in Ecology and Ecosystem Science from the University of Pennsylvania (BS), University of Washington (MS), and Cornell University (PhD), with a year of post-doctoral experience from Stanford University. He also holds a courtesy appointment in the Department of Forest Science at Oregon State University.

Janet Erickson is the information exchange specialist for the CFER program. She is responsible for conveying information about the CFER program and its research projects to land managers and other audiences. She develops and manages the production of a variety of information products, such as the CFER web site, written publications, videos, displays, field tours, and symposia. Janet received her BS in Biology from Pacific Lutheran University and her MS and PhD in Wildlife Science from the University of Washington.

Michelle Donaghy Cannon is a PhD student in the Department of Forest Science and the Department of Fisheries and Wildlife. She is studying the influence of woody plant community composition in riparian areas on birds.

John Cissel is the BLM Western Oregon Science Liaison stationed in the Forestry Sciences Laboratory at Oregon State University. John's role is to help connect the western Oregon BLM districts to science by integrating management needs into research projects, developing management studies to address management questions, sharing recent science findings with managers, and by developing and demonstrating applications of new science concepts and findings. John has a BS in Forestry from Michigan State University, MS in Forest Management and Operations Research from Penn State University, and has completed additional coursework in forest ecology at Oregon State University. He also holds a courtesy appointment in the Department of Forest Science at Oregon State University.

Dr. Paul D. Anderson current position is a Supervisory Research Forester, Team Leader of the Biology and Culture of Forest Plants Team in the Resource Management and Productivity Program for the USDA Forest Service, Pacific Northwest Research Station Corvallis, OR. His areas of expertise include Ecological Plant Physiology and Silviculture. His research interests include physiological and ecological foundations of silviculture, forest and wildland restoration, plant genecology and forest response to climate change. He received a PhD in Ecophysiology and Silviculture at the Department of Forest Resources, University of California, Berkeley, 1991; MSF in Silviculture and Forest Soils, Department of Forestry and Natural Resources, Purdue University, 1981; and BS in Forest Ecology and Silviculture, College of Forestry, University of Minnesota, 1979. Previous Positions include Research Associate, Silviculture and Ecophysiology, University of Minnesota Aspen and Larch Genetics Cooperative, 2000 – 2002; Research Plant Physiologist, USDA Forest Service, North Central Research Station, 1993- 2000; Adjunct Professor, Department of Biological Sciences, California State University, Chico, 1993-1995; Research Associate, Forest Ecophysiology, University of California, Berkeley, 1992-1993; Research Associate, Forest Ecophysiology, California State University Chico/Lawrence Livermore National Laboratory, 1991-1992; Research Associate, Forest Ecophysiology, Environmental Sciences Division, Lawrence Livermore National Laboratory, 1988-1991; Research/Teaching Assistant, Silviculture, Mensuration, Forest Ecophysiology, University of California at Berkeley, 1982-1988; Research/Teaching Assistant, Silviculture, Purdue University, 1979-1981.

Klaus Puettmann is an Associate Professor Department of Forest Science, Oregon State University. His research interests are in Silviculture and forest ecology – natural and artificial regeneration, dynamics of plant interactions and management of diverse stand structures. He received a PhD in (Silviculture, Forest Modeling), 1990 Oregon State University, Corvallis, Oregon and a Diplom-Forstwirt in Forstwissenschaft (Forest Science), 1986, Albert Ludwigs Universitaet, Freiburg, Germany.